Examiners' Report/
Principal Examiner Feedback

Summer 2016

Pearson Edexcel International A Level
in Mechanics M3 (WME03)
Paper 01

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Candidates should take care to present their work neatly as examiners have to be able to read the work to establish the candidate's intentions! Overwriting a mistake is a dangerous practice as sometimes the resulting work is illegible. Fractions are often written on a single line making it very awkward to read the characters/numerals and this was sometimes combined with cancelling which then made it almost impossible to decipher the work. The use of pens producing 'smudged' writing is a further factor in the difficulties faced by examiners.

Some candidates appear to read the questions too quickly as their initial attempts proceed down an incorrect route and some persist in using their incorrect answer in the next part of their solution instead of the answer given in the question. Clearly labelled diagrams can be a significant help in producing succinct solutions especially in questions set in context, such as question 5.

Marks were lost due to failing to round to 2 or 3 significant figures when using g = 9.8 ms^{-2}. Over specification, such as by leaving their answer as 7/5 (qu 7) after using g = 9.8 ms^{-2} is also penalised. Using rounded answers in subsequent working, leading to incorrect final results loses marks unnecessarily.

Question 1

This was a straightforward and familiar question which produced a very good response. Nearly all candidates resolved vertically and obtained an equation of motion horizontally with just one or two using a 'triangle of forces' type of approach. A small number of candidates arrived at the correct solution without resolving and these always seemed to be working back from the given answer. It is possible that they arrived at their opening line by considering a triangle of forces, but without actually showing the triangle this counted as being "without sufficient working" and no marks were given. A very small number misread the question and had the particle moving in a vertical circle.

Question 2

Part (a) was generally answered very well. Almost all candidates used Hooke's law correctly and hardly any forgot to add on 5a at the end. The proof of SHM was less successful, mainly because candidates did not use a mass of 2m with the acceleration term. In general they knew to use Newton's second law and most correctly formed Hooke's law with a variable extension, mostly with the correct centre. Some candidates used a rather than $\ddot{x}$ for the acceleration and consequently lost marks as a is non-directional. The method mark in (c) was usually gained, although many lost the final mark having used m in (b).

Question 3

Most candidates did not realise that having the particle moving on a rough table significantly complicated the situation as friction might cause the particle to stop moving before the string became slack. Hence the significance of part (a) was not appreciated and OB was calculated first and then stated to be less than l. The best solutions either used the inequality approach shown in the mark scheme or showed that the particle still had kinetic energy at the instant when the string became slack. The most common error was to assume that there was still some EPE after the string had gone slack and an extra EPE term was included in the energy equation. A more worrying error was to consider just forces and not consider energy at all.

Question 4

Part (a) should be a completely standard and learnt proof but very few explicitly gave a general proportion statement, followed by a clear statement about *mg* and *R*, leading to an expression for *k*. Many went straight in at $mg = k/R^2$, whilst others started with the general statement before introducing *mg* and *R* on separate lines, losing the connection between them. There were plenty of physicists that insisted on using *GMm*, which just made their working harder to keep accurate.

In part (b) most knew what was required but many did not set their work out as formally as they ought to, making it hard to be certain whether correct signs had been used. The most common approach was to use definite integration, but this was often only half shown, with the candidates going straight to a difference in v^2, where one of the velocities went on to become 0. The more convincing candidates went to $-u^2$ and a negative integral, so it was clear that signs were being used consistently, but others lost marks because there appeared to be a double sign error. Some candidates used a distance of $R/20$ and others paired up the distances and speeds incorrectly.

Question 5

This question required a careful analysis of the context in which the problem was set with a good diagram not seen nearly as often as it should have been. In part (a), the initial approach required was almost universally realised with an attempt to find ω via the period of the oscillation. However it was surprising to see many mixing up minutes with the decimal of an hour using $T = 12.15$ rather than $T = 12.25$. There were variations on this theme with

$T = 1215$ occasionally seen. The next step required the amplitude and value of the displacement at the bottom of the ladder from the centre of motion and it was here that those with a good diagram were least likely to make errors and use the correct values ($a = 5$ and

$x = 4$). Common errors were to take the amplitude as 10 or 4 and use x as 9 or 1 and combinations of these. A few candidates successfully completed part (a) by using $x = a\sin\omega t$ and then differentiating to find $v = a\omega\cos\omega t$. Those few who worked in seconds rather than hours did need to convert their speed into m/hr at the end; some did and others did not.

In part (b) there were many correct approaches in finding the time when $x = \pm 4$ but many then found it difficult to form a complete solution. Other than the two approaches in the mark scheme, another succinct method seen was to find the two appropriate solutions to

$a \sin \omega t = \pm 4$ or $a \cos \omega t = \pm 4$ and subtract.

Question 6
Generally this question was answered well. Part (a) proved very straightforward and was answered well by almost all candidates. Occasionally $v^2 = u^2 + 2as$ was used rather than energy and scored no marks. In part (b) most candidates were familiar with motion in a vertical circle and wrote down the equation of motion in the radial direction, equated the reaction to zero and, after substituting for v at some stage, obtained a value for u. It was disappointing that some did not realise that at B the reaction was zero and so could make no further progress.
The solution for the projectile motion in part (c) relies on finding the components of the velocity at B and if this was not done marks could not be scored. However some of the marks for this part of the question were available independently of part (b) and a few of those who made little progress in part (b) did manage to score well here. Having found the vertical component of the speed at B there were a number of ways to find the time of flight, some more involved than others. The method in the mark scheme using $s = ut + \frac{1}{2}at^2$ was the most common and successful with candidates using their calculator functions to write down the roots of their quadratic. One alternative seen involved finding the vertical component of velocity at C using $v^2 = u^2 + 2as$ and then $v = u + at$. Most then attempted to find the horizontal distance moved using the horizontal component of velocity but then quite a few stopped at this stage or added 0.5 instead of 0.3 to find OC.
A significant number failed to give their final answer correct to 2 or 3 sf or rounded incorrectly, with 0.6m and 0.599m often seen.

Question 7
There was a disappointing response to the standard piece of bookwork in part (a). Quite a few simply failed to attempt the question or gave up after a few lines but there were many neat, well argued solutions. However with a given answer it is crucial that no steps are omitted which in other circumstances would not be penalised, and as a consequence of missed steps some candidates lost one or two marks. There were a number of responses which ignored the given request for a general cone and proved the result for the cone involved in Figure 2 and many used an incorrect equation for the line. Most candidates made a sensible attempt at setting up the moments equation in part (b) and generally the appropriate masses and distances were used. A significant number chose to take moments about the vertex, but they nearly always went on to convert to the correct distance. Although not many ran into problems with all of the π's and 1/3's, candidates could have made their lives a lot easier by simplifying to ratios before forming their equations. In part (c), candidates generally struggled to find correct masses, with the most common error being to use M as the mass of S. In general candidates understood the mechanical implication and put the final centre of mass at O. A good number again took moments about the vertex, but this was generally done correctly (albeit with usually incorrect masses).

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